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BLOODLESS AMPUTATION AT THE HIP-  
JOINT BY A NEW METHOD.

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## BLOODLESS AMPUTATION AT THE HIP-JOINT BY A NEW METHOD.

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Prevention of unnecessary loss of blood during the performance of an operation is one of the modern requirements of successful surgery. Efficient prophylactic hæmostasis has not only greatly reduced the mortality of capital operations by preventing the loss of an amount of blood incompatible with life, but it has proved equally useful in favorably influencing the subsequent reparative processes. Experimental research and clinical observations have demonstrated conclusively that diminution of intravascular tension caused by hæmorrhage is one of the potent factors which favors the origin and spread of infection, and besides retards the healing of the wound.

The importance of a recourse to prophylactic hæmostatic measures is proportionate to the size of the blood-vessels which must unavoidably be severed in an operation. Thus in amputation of the extremities, without special precautions, the immediate risk to life from hæmorrhage is greater the nearer the operation approaches the trunk. While a finger, or a toe, or even a hand, or foot, might be amputated without the use of a tourniquet, or elastic constrictor, without incurring any immediate risk to life from the loss of blood, such a procedure in amputation at the shoulder- or hip-joint would jeopardize life on the operating table. In all amputations below the shoulder- and hip-joints we have now in Esmarch's elastic constrictor a reliable measure with which we can absolutely control hæmorrhage during the operation and thus minimize the loss of blood. Elastic constriction is the simplest and safest method of preventing hæmorrhage wherever it can be applied.



*History of Amputation at the Hip-Joint.* More than one hundred years ago two English surgeons, Kerr and Thomson, ventured to perform exarticulation at the hip-joint. Both of these patients died. Before that time (1739) Volher, a Danish surgeon, and Puthod, a Swiss, called attention to the feasibility of this operation and practiced it on the cadaver. From the year 1757 to 1759 the operation was done on dogs, cats and sheep by a number of French surgeons, notably LeFevre, Lecomte, Moublet, Sue, Gamet and Barbet, the last of whom received the prize from the Paris Academy of Medicine offered for the best paper on this subject. A decided opposition to this operation was raised and maintained by Stromeyer, who made the statement: "von den Exartic. des . H. ist es noch nicht erwiesen ob sie uberhaupt einen Platz unter den chirurgischen Operationen verdienen." Löffler was even more positive in his opposition to the operation, as appears from the following passage: "von der man noch nicht einmal gewiss wisse, ob ein erwachsener Mensch sie uber stehen konne." Since 1860 the operation has been performed by surgeons of all nations. The best results so far have been reported by Curling, who lost only one out of five cases. Langenbeck had four recoveries out of twelve cases. The mortality has ranged between 59 and 89 per cent. inclusive of the cases reported by G. A. Otis, which occurred during the War of the Rebellion. Shippen's successful case attracted world-wide attention. During the campaign of 1864, 1866, and 1870-1871 not a single patient recovered from the operation. Mortality has always been greater when the indication for operation was furnished by a trauma, especially gunshot wounds, Luning (*Über die Blutung bei der Exarticulation des Oberschenkels und deren Vermeidung. Dissertation, Zurich, 1876*) collected 486 cases in which the mortality was 70 per cent. Gunshot wounds, 239 cases, mortality 98 per cent.; pathological indications, 153 cases, mortality 42 per cent. Larrey introduced the operation in military surgery, and after six failures obtained a successful result during the Russian campaign, the first successful case on record. After the publication of his first three cases he induced military surgeons of other countries to perform the operation, and Brownrigg and Guthrie soon reported each a

successful case. The operation was introduced again into civil practice, and in 1812 Baffos reported the first successful case. It appears that Mulder, of Groningen, operated with success in 1798. In Germany the operation was first performed with success in 1821 by Wedemeyer, and in 1822 by Krimer, whose patient survived the operation, but died later of tetanus. Krimer was so much opposed to the operation that he suggested the propriety of tying the common iliac artery by opening the peritoneal cavity, and in this manner cause gangrene of the limb with a view of producing spontaneous amputation. Although A. Cooper operated with success in 1824, he was not inclined to favor the procedure. Diefenbach favored the operation and claimed that two out of seven patients could be saved by it, an estimate which agrees with the statistics since his time. Dupuytren and Pirogoff, although they lost all their patients subjected to this operation, championed its cause.

*Development of Technique of Bloodless Amputation at Hip-Joint.* The technique of controlling hæmorrhage in amputations at the hip-joint has undergone many changes during the last twenty years, and is still far from being perfect. The first attempts were directed towards rendering the limb bloodless by compression of the aorta near its bifurcation. Tourniquets for the purpose were invented by Pancoast, Esmarch, Syme, Tieman, Signeroni, Lister and Brandis. This instrument was first used by Gamgee in 1863. This method of rendering the operation bloodless is uncertain, as the compressor may become displaced during sudden movements of the patient, and is open to the serious objection that, when efficiently applied, it cuts off the arterial circulation from nearly one-half of the body, a circumstance attended by no inconsiderable immediate risk to life from sudden vascular engorgement of important internal organs. In several cases in which this instrument was used severe venous hæmorrhage was encountered. An additional objection to the employment of this instrument is the fact that organs interposed between the abdominal wall and the spine against which the pressure is made may be injured. Digital compression of the femoral or external iliac artery, a method of controlling hæmorrhage inaugurated by Abernethy, is unreliable, as the



fingers are very apt to slip during the manipulation of the limb, and in that it does not cut off the blood supply of the remaining large arterial trunks of the limb.

The next step in the development of the technique of bloodless amputation at the hip-joint was devised by Mr. Davy, and consists in instrumental compression of the common iliac artery against the pelvic brim. The instrument consists of a smooth rod or cylinder of hard wood or metal, from 18 to 25 inches in length, and terminating in a conical, blunt extremity. The directions given for the use of this instrument are the following: "Oil having been injected into the bowel, the conical or larger end of the lever is introduced into the rectum, and is passed in the direction of the vessel to be compressed. The surgeon, feeling the end of the instrument through the abdominal wall, directs it to the common iliac as it lies on the pelvic brim. The handle of the instrument is now carried to the thigh of the opposite side, and is then raised so that it may act as a lever, for which the anus serves as a fulcrum." This method is not only unreliable, but is inapplicable in cases where no mesorectum exists, and has more than once been the cause of serious damage to the bowel, and for these reasons was never generally adopted and has now fallen into well-merited disuse.

Preliminary ligation of the common femoral artery was advocated by von Volher, Puthod, Moublet, Larrey, Delpech; Orten. A. Cooper, Blandin, Velpeau, Roser, Roux and Boyer. von Volher, Larrey and Roser tied at the same time the femoral vein. Scoutetten proposed preliminary ligation of the external iliac artery. Against preliminary ligation were arrayed Lalouette, Abernethy, B. Bell, Richter, Guthrie, Baffos, Langenbeck, S. Cooper, Pelikan, Beclard, Dupuytren, v. Walther, Krimer, Bryce and Lenoir. Preliminary ligation as well as compression of the femoral vessels in the anterior flap by manual compression do not render the operation sufficiently bloodless and cannot be relied upon in cases in which the loss of several ounces of blood would imperil the life of the patient. Pirogoff, von Pitha and Volkman advised ligation of the principal vessels in the incisions made in forming the flaps prior to their division.



Out of 39 cases of preliminary ligation 11 died, while of 29 treated by digital compression 17 recovered, showing that preliminary ligation is less safe than digital compression. In three cases the profunda had a high origin, and the object of the preliminary operation was not realized. Linhart lost one case by hæmorrhage from the branches of the hypogastric artery. Beck had a death from secondary hæmorrhage at the point of ligation. E. Rose does not rely on digital compression, preliminary ligation of common femoral artery or constriction, but ties each vessel double before cutting it. The flaps are made from without inwards with a small scalpel, and as the vessels are exposed they are tied. Each muscle is picked up, compressed at two points, and divided between and all bleeding vessels tied before going any further. In this manner the short anterior and long posterior flaps are made and the hæmorrhage dealt with as in the extirpation of a tumor. Pean operates in a somewhat similar manner, but relies on hæmostatic forceps instead of ligatures in preventing hæmorrhage during and after the operation. Soon after the introduction of the bloodless method of operating by elastic constriction by Esmarch the principle of this treatment was applied to high amputations of the thigh. Esmarch gives the following directions: "In high amputations of the thigh, the tube is tightly wound once or twice around the limb just below the flexure crease of the thigh, the ends are crossed above the groin, passing around over the posterior surface of the pelvis, and are finally hooked together by the chain across the abdomen. A firmly-rolled linen bandage may also be laid over the iliac artery, directly above Poupart's ligament, as a pad, and tightly pressed upon the artery by several figure-of-eight turns of a strong rubber bandage."

Mr. Jordan Lloyd employed for the same purpose a common calico roller which was applied over the external iliac artery, over which was placed a strip of black India-rubber bandage about two yards long, which was doubled, the center of this bandage resting between the tuberosity of the ischium and the anus, the ends, drawn tight enough to arrest the circulation completely, were firmly held at a point corresponding to the center of the iliac crest on the side to

operated upon. In order to prevent slipping away of the band from the compress, these were fastened together with a safety pin. By this method of compression Mr. Lloyd expected to prevent hæmorrhage not only from the femoral and its branches, but also from the branches of the internal iliac. The prevention of hæmorrhage by this method rests entirely in the hands of the assistant, and consequently cannot be relied upon under all circumstances. In disarticulation of the thigh through an external or anterior racket incision, elastic constriction as heretofore practiced has been very unsatisfactory indeed, and main reliance was placed on dividing the tissues quickly after disarticulation, seizing and tying the principal vessels. Elastic constriction has been made more serviceable since Esmarch devised his method of amputation at the hip-joint by first making an ordinary high amputation of the thigh, leaving the removal of the proximal end of the femur until all the principal vessels were tied. Although this method of operating is generally accredited to Esmarch, similar claims are made by the Germans for Pitha, the French for Lacanchie, the Americans for Bontecou. It is well known that Dieffenbach performed it in 1826 and Ravaton proposed it before that time with the advice to make the vertical incision first. Primary re-amputation of the stump requires section of the femur and tends to increase the hæmorrhage from the vertical incision after the ligation of the principal vessels of the stump, circumstances which can hardly fail to add to the gravity of the operation. One great obstacle to the use of the elastic constriction in this operation has been the slipping of the constrictor after the circular amputation. For the purpose of preventing this accident the thigh below the constrictor has been transfixed by long needles or skewers. Trendelenburg transfixes the thigh by a single needle passed in front of the neck of the femur and beneath the large vessels. Mr. Myles thrusts a stout steel skewer straight through the thigh from before backwards. The needle is made to enter an inch below Poupart's ligament, and just to the outer side of the femoral artery it passes to the inner side of the neck of the femur, and emerges a little above the gluteal fold. A rubber cord in the form of a figure-of-eight is passed around



the projecting ends of the skewer. Wyeth uses two strong mattress-needles for the purpose of preventing slipping of the elastic constrictor. The point of one is inserted an inch-and-a-half below, and just to the inner side of, the anterior superior iliac spine, and is made to traverse the muscles, passing about halfway between the great trochanter and the iliac spine, external to the neck of the femur, and emerging from just behind the trochanter. The second needle is entered an inch below the level of the groin internal to the saphenous opening, and, passing through the adductors, the point coming out about an inch-and-a-half in front of the tuberosity of the ischium. A piece of strong rubber tube half-an-inch in diameter, and long enough when tightened to go five or six times around the thigh, is now wound very tightly around and above the fixation needles, and tied. The elastic constrictor and needles are removed as soon as the circular amputation is completed and the principal blood-vessels have been tied, whereupon the proximal end of the femur is removed. It appears immaterial to me whether one or two needles are employed, as the object of using them is simply to prevent slipping of the elastic constrictor, which is fully accomplished by using one needle or skewer.

Dr. A. B. Keyes, late interne, Cook County Hospital, has devised a much simpler and I believe better method of controlling hæmorrhage in amputations at the hip-joint by Furneaux Jordan's method. (*The Chicago Medical Recorder*, May, 1892). After dislocating the head of the femur and separating the periosteum with the attached soft parts down to the proposed point of amputation he constricts the soft parts with a bandage composed of several layers of aseptic gauze folded to about two inches in width, which he ties into a loop and constricts with a hammer handle, "Spanish windlass" fashion after the limb has been rendered comparatively bloodless by holding it for a short time in a vertical position. The circular amputation is then made below the point of constriction in the usual manner. Dr. Keyes reports two cases successfully operated upon by this method. Although the probability of slipping of the constricting bandage is greatly lessened by applying it after the femur

has been dislocated and its upper end cleared of soft parts, such an accident is still possible after the circular amputation has been made, and the management of the constrictor requires a reliable assistant, which must be looked upon as a serious drawback in case the necessary assistance cannot be readily secured. I consider the preliminary dislocation of the head of the femur and clearing the upper end of the bone by the external ratchet incision far preferable to Es-march's method of amputation at the hip-joint, provided hæmorrhage can be safely controlled during the subsequent steps of the operation without the aid of a skilled assistant. I prefer this method of dealing with the femur because the removal of the proximal end of the femur after the circular amputation is a much more difficult and time-consuming task than when the whole shaft of the femur can be used as a lever, at the same time the hæmorrhage attending the external incision is much greater after ligation of the femoral vessels than when the incision is made and the head and upper end of the femur are liberated prior to making the amputation and before the circulation in the femoral vessels is interrupted.

*Causes of the Great Mortality Attending Amputations at the Hip-joint.* Hoff estimates the mortality of high amputations of the thigh at 90 per cent. Langenbeck and Volkmann regard high amputations more dangerous than exarticulation at the hip-joint. Amputation at the hip-joint has always been looked upon as one of the most bloody operations in surgery. The estimation of the loss of blood has always been unreliable and its value only relative. Voelkner studied the effects of the loss of blood usually incurred in this operation in 89 fatal cases, of which number five died during the operation, eight during the first five hours, 29 during the first day and 18 during the first five days. According to Bardeleben's observations, one-fourth of all the cases die during the first 48 hours, and more than one-half within the first week. Of 23 fatal cases collected by Luning, five per cent. died during the operation, 12½ per cent. during the first hour following the operation, 26 per cent. during the first five hours, 46 per cent. during the first 24 hours, 57 per cent. during the first 48 hours, and 70 per cent. during the



first five days. Secondary hæmorrhage yielded only a very small mortality.

Shock, or, as Pirogoff called it, "general traumatic torpor or stupor," cannot be ignored as a frequent cause of death in an amputation involving the removal of an entire limb. Langenbeck ignored shock as a cause of death in this operation, and does not believe that any of his patients died from it. He accuses chloroform and loss of blood during or occurring soon after the operation as the direct and immediate causes of death. The same opinion is shared by Rose, who attributes the fatal issue in his cases to acute anæmia caused by loss of blood. The amount of blood lost is no criterion, as a patient in robust health may lose a pint or more with impunity, while in debilitated subjects the loss of a few ounces may turn the balance in the direction of failure. In anæmic subjects the use of anæsthetics is more dangerous than in otherwise healthy, robust persons, and MacCormac has called attention to the necessity of using anæsthetics with the greatest care during the performance of this operation.

Statistics show that in the majority of cases hæmorrhage was the cause of the great mortality which attends this operation during the first five days, including at least 70 per cent. of the total mortality. Volkmann has called attention to the profuse parenchymatous oozing which frequently attends this operation, and which has done so much towards adding to its great mortality. Enough has been said to show the necessity of taking special precautions in performing this operation to prevent by appropriate measures the loss of blood. In Luning's tabulated cases, 120 in number, the amount of blood lost is specified. In 6 the hæmorrhage was enumerated as the direct and sole cause of death. In 17 the hæmorrhage was taxed as being severe, of these 12 died during the first 5 days, and 4 later. In 13 cases it is stated that the hæmorrhage was not severe, of these 8 died the first day, two after the fifth, and 3 recovered. In 43 further cases the amount of blood lost was said to have been slight, of this number 16 died during the first period, 9 during the second, and 18 recovered. In 6 cases the loss of blood was estimated as being "minimal," and of this number

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only 1 died, and in this case death occurred on the fourth day. In two cases no blood was lost, one dying of shock, and the other from loss of blood sustained before the operation was made. These cases serve a useful purpose in establishing the causative relation which exists between hæmorrhage and the great mortality which attends this operation. Of 9 cases in which the loss of blood was variously estimated between two pounds and eight ounces, 2 died before the fifth day, 5 after that time, and two recovered. In 16 cases the estimate varies between 6 and 3 ounces; of this number, 6 died during the first period, during the last 3; six recovered, and in 1 case the final result is doubtful. Two ounces and less was the amount of blood lost in 8, with 2 deaths before the fifth day, one from the effects of chloroform.

The femoral artery is not the only source of dangerous or fatal hæmorrhage. In 3 cases reported by Luning the profunda femoris artery had a high origin and caused serious hæmorrhage, and in two others the control of hæmorrhage was difficult, and all these patients died during or soon after the operation. Larrey, Ph. von Walther and Jager mention the obturator, ischiatic and circumflex arteries as a source of troublesome hæmorrhage. Linhart and Langenbeck lost each a case from hæmorrhage from branches of the hypogastric artery. Zeis one from hæmorrhage from the obturator and profunda femoris arteries. Volkmann called attention to the severe parenchymatous bleeding which often attends this operation. In one instance two pints of blood were lost from this source, and about twenty muscular branches had to be tied. Dupuytren was aware that in amputation at the hip-joint venous hæmorrhage is occasionally quite severe, which he attributed to defective respiration. Butcher alludes to hæmorrhage from the femoral vein as a source of danger, and Rose insisted that the bleeding from this vessel should receive prompt attention. The cardinal points in a typical amputation at the hip-joint are: 1. Disarticulation of the head and isolation of the upper part of the femur from the attached soft tissues through an external straight incision. 2. Elastic constriction of the thigh just below the pelvis until the amputation has been completed and the principal vessels have been tied. 3. For

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mation of cutaneous flaps and circular sections of deep tissues below the point of constriction.

I will now proceed and give you a somewhat detailed account of the operation I have devised, which will further elucidate the points just enumerated.

*External Incision.* The external incision (Fig. 1) is Langenbeck's incision for resection of the hip-joint, differing from this only in so far that it is carried a little farther in a downward direction in order to afford more ready access to the shaft of the femur as far as the proposed line of section through the deep soft parts. The incision is made about eight inches in length parallel to the long axis of the femur directly over the center of the great trochanter, extending about three inches above the upper border of the trochanter. When the knife reaches the trochanter from above downwards its point should be kept in contact with the bone the whole length of the remaining part of the incision. The margins of the wound are now retracted and any spurting vessels, such as the circumflex arteries, secured by applying pressure forceps.

*Dislocation of Head of Femur and Clearing of Upper Portion of Shaft.* During this and remaining steps of the operation the body is drawn down so that the pelvis rests upon the lower edge of the table, so that the position of the thigh can be conveniently changed by the assistant who is entrusted with this work. The pelvis is tilted sufficiently upon the opposite healthy side to facilitate this step of the operation. The trochanteric muscular attachments are now severed close to the bone with a stout scalpel. The clearing of the digital fossa and division of the tendon of the obturator externus requires special care. The thigh is now flexed, strongly adducted, and rotated inwards when the capsular ligament is divided transversely at its upper and posterior aspect. The remaining portion of the capsular ligament is severed while the thigh is brought back to a position of slight flexion. After complete division of the capsular ligament the thigh is rotated outwards, and, if possible, the ligamentum teres is divided; if this cannot be readily done the head of the bone is forcibly dislocated upon the dorsum of the ilium by flexion, adduction and rotation inwards of

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the thigh. After dislocation has been effected the trochanter minor and upper part of shaft of femur are cleared by using alternately scalpel and periosteal elevator. In cases where it is deemed advisable the periosteum can be preserved. At the completion of this part of the operation the femur is in a position of extreme adduction. (Fig. 2) By pushing the femur through the opening as much of the shaft can be cleared as may be desired for the purpose of making a low amputation.

*Elastic Constriction.*—During the operation so far, if the surgeon has kept in close contact with the bone and has used the knife sparingly and the periosteal elevator freely, the hæmorrhage has been very slight, much more so than if this part of the operation had been reserved for the last as is done in Esmarch's method. Further loss of blood during the subsequent steps of the operation is now prevented by elastic constriction applied in the following manner: The limb is brought down in a straight line with the body, the thigh slightly flexed so as to push the upper free end of the femur forward into and beyond the wound, when a long stout hæmostatic forceps is inserted into the wound behind the femur and on a level with the trochanter minor when in normal position; the instrument is pushed inwards and downwards in a direction about two inches below the ramus of the ischium and just behind the adductor muscles. As soon as its point can be felt under the skin in this location an incision is made through the skin about two inches in length through which the instrument is made to emerge. After enlarging the tunnel made in the soft tissue by dilating the branches of the forceps, a piece of aseptic rubber tubing three-quarters of an inch in diameter and about three or four feet in length is grasped with the forceps in the middle, and is drawn along the tunnel as the forceps is withdrawn. After this has been done the rubber tube is cut in two at the point where it was grasped by the forceps. With one-half of the tube the anterior segment of the thigh is constricted sufficiently firm to completely interrupt both the arterial and venous circulation. Prior to constriction the limb is rendered bloodless by elastic compression, or by keeping it in a vertical position for a few minutes, or both of these methods are



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combined in preventing unnecessary loss of blood. The elastic constrictor is either tied (Fig. 3), or, still better, after having secured the necessary constriction both tubes are caught and held by a strong pair of forceps at a point where they cross each other. The posterior segment of the thigh is constricted by the remaining rubber tube, which is drawn sufficiently tight behind, when the ends of the tube are made to cross each other and are brought forward and made to include the anterior segment, when they are again firmly drawn and tied, or otherwise fastened, above the first constrictor. (Fig. 4.) As the anterior segment of the thigh contains the principal blood-vessels this method of applying the posterior constrictor furnishes an additional security against hæmorrhage from the large vessels when divided by the circular incision.

*Cutaneous Flaps.* Muscular flaps should be avoided in all amputations at the hip-joint. Inclusion of muscles in the flaps is often accountable for incomplete removal of malignant or infective disease for which the amputation is made. An ideal stump can be made by cutaneous flaps and circular section of the muscles. If the conditions for which the amputation is to be made permit it a long oval anterior and short posterior skin flaps should be made. If the condition of the soft tissues of the thigh are such as to render this impracticable healthy skin must be obtained by making, for instance, a long external and short internal flaps, or a long posterior and short anterior, according to the location and extent of the disease. The long anterior and short posterior flaps are best adapted for a useful stump and efficient drainage. In making the anterior flap the incision is commenced at the lower terminus of the straight incision, dividing the tissues down to the muscles it is carried downwards then in a gentle curve across the anterior aspect of the thigh, (Fig. 5), embracing about two-thirds of the circumference of the thigh, it is finally carried upwards to a point on the inner side just below the opening in the skin occupied by the constrictors. The posterior flap is made in a similar manner, but about one-third shorter. The flaps are now reflected to the point where the muscles are to be divided, and should always include the deep fascia. The flaps are to be held out

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of the way, while the operator completes the amputation by dividing the muscles with an amputating knife. This last incision will correspond to a point on the femur to where the bone has been deprived of soft parts. The incision through the muscles should be slightly conical with the apex of the cone directed upwards and corresponding to the location of the tube made by the enucleation of the femur. (Fig. 6).

The sciatic nerve is now resected to the extent of an inch or more, and the femoral artery or arteries tied with catgut in the usual manner. The femoral artery and vein are now isolated and a second catgut ligature, including both of these vessels, applied half-an-inch higher up. In this manner the vein is ligated, while the artery is secured by a double ligature which places the end of the vessel in the best possible condition for definitive closure and cicatrization. The inter-muscular septa are now examined and any vessels that can be seen are tied. While the posterior constrictor is removed the posterior half of the stump is firmly compressed by applying a hot moist compress of aseptic gauze over which manual pressure is made for a short time for the purpose of diminishing parenchymatous oozing. After removal of the compress additional bleeding vessels are secured. The anterior part of the amputation surface is treated in a similar manner; after the removal of the anterior constrictor but few, if any, additional ligatures will be required here. The double constrictor presents many advantages in the prevention and treatment of hæmorrhage in this amputation. Slipping of the constrictors is an impossibility, and they control the hæmorrhage absolutely while their proper use divides the wound into two halves, each of which is separately treated, thus reducing the loss of blood to a minimum. I applied this method to one case recently, and every one present was favorably impressed with the ease with which the hæmorrhage was controlled during the amputation, and astonished at the small amount of blood lost after the removal of the constrictors. (Fig. 7 shows the appearance of the stump prior to suturing of the flaps.) As this method of amputation does not require the presence of a skilled assistant it will prove of special value in emergency cases. The operation can be performed with instruments contained in

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every pocket-case. Should an elastic tube not be at hand the constriction can be made in the manner described by substituting for it a cord made of sterilized gauze or bandage.

The following conclusions represent the principal advantages of the bloodless amputation at the hip-joint as described in this paper:

1. Preliminary dislocation of the head of the femur and clearing the shaft of this bone of all soft tissues down to the proposed line of amputation through an external straight incision requires less time, is attended by less hæmorrhage and shock than when this part of the operation is done after circular amputation, as advised by von Esmarch and others.

2. The external straight incision is the same as von Langenbeck incision for resection of the hip-joint, differing only in length.

3. After dislocation of the femur the soft tissues are tunneled with a hæmostatic forceps which is entered through the external wound on a level with the trochanter minor to a point on the inner aspect of the thigh behind the adductor muscles and about two inches below the ramus of the ischium where a counter opening two inches in length is made.

4. Bloodless condition of the limb should be secured by elastic compression or vertical position prior to tying the elastic constrictors.

5. An elastic tube three-quarters of an inch in diameter and about four feet in length is grasped with the forceps in the center and drawn through the tunnel made by the forceps.

6. After dividing the elastic tube in the center the base of the thigh is constricted by drawing firmly and tying the anterior constrictor in front of the anterior section, while the posterior constrictor after being drawn tight behind the posterior section the two ends are crossed and then made to encircle the whole thigh, when the ends are again drawn firm and tied or otherwise secured above the anterior constrictor.

7. A long and a short oval cutaneous flap should invariably be made in all amputations at the hip-joint.

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8. In preference a long anterior and a short posterior flap should be selected.

9. The transverse section through the muscles should be somewhat conical in shape, the apex of the cone corresponding to the tunnel made by enucleation of the upper portion of the shaft of the femur.

10. Resection of the end of the sciatic nerve and ligation of all vessels that can be found should be done before the removal of the constrictors.

11. The femoral arteries should be secured by a double catgut ligature half an inch apart, the one on the proximal side including also the accompanying vein.

12. The posterior constrictor should be removed first, and all hæmorrhage arrested by ligation and compression before the anterior constrictor is removed.

13. The upper part of the wound corresponding to the acetabulum should be drained with an iodoform gauze tampon, and the remaining part of the wound by one or more tubular drains.







